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Upset Tummy? MOM to the Rescue!

A Colorful Antacid Demonstration

Publication No. 10261

Introduction

Mix milk of magnesia (MOM) with universal indicator and observe the dramatic rainbow of colors as the antacid dissolves in the simulated stomach acid! This is a great demonstration to teach concepts of acids and bases, solubility, K_{sp} and "antacid-testing" consumer chemistry.

Chemical Concepts

- Acid–base neutralization
- Solubility and K_{sp}
- Antacids

Materials (for each demonstration)

Milk of magnesia, 20 mL
Hydrochloric acid, HCl, 3 M, approximately 20 mL
Universal indicator solution, 1%, 4–5 mL
Water, distilled or deionized, 800 mL
Beaker, 1-L (or other large beaker)
Beral-type pipets, 2
Graduated cylinder, 25-mL or 50-mL
Ice, crushed (or ice cubes)
Magnetic stir plate (or stirring rod)
Magnetic stir bar

Safety Precautions

Milk of magnesia is intended for laboratory use only; it has been stored with other non–food-grade laboratory chemicals and is not meant for human consumption. Hydrochloric acid solution is toxic by ingestion and inhalation and is corrosive to skin and eyes. Universal indicator solution is an alcohol-based flammable solution. Consult current Material Safety Data Sheets for further safety and handling techniques. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

Procedure

1. Measure 20 mL of milk of magnesia using a graduated cylinder and pour it into a 1-L beaker.
2. Place the 1-L beaker on a magnetic stir plate. Add a magnetic stir bar to the beaker.
3. Add water and crushed ice (or ice cubes) to give a total volume of approximately 800 mL. Turn on the stir plate so as to create a vortex in the mixture.
4. Add about 4–5 mL (about 2 pipets full) of universal indicator solution. Watch as the white suspension of milk of magnesia turns to a deep purple color. The color indicates that the solution is basic.

5. Add 2–3 mL (1 pipet full) of 3 M HCl. The mixture quickly turns red and then goes through the entire universal indicator color range back to purple.
6. Repeat this process, adding HCl one pipet full at a time, waiting after each addition until the mixture turns back to blue–purple.
7. The process can be repeated a number of times before all of the $Mg(OH)_2$ has dissolved and has reacted with the HCl. As more acid is added, the color changes will occur more rapidly and eventually the suspension will be completely dissolved. This will be evidenced by a clear, red solution.

Discussion

The active ingredient in milk of magnesia is magnesium hydroxide, $Mg(OH)_2$. Magnesium hydroxide forms a suspension in water since it has a very low solubility—0.0009 g/100 mL in cold water and 0.004 g/100 mL in hot water.

Initially in the demonstration, the solution is basic due to the small amount of $Mg(OH)_2$ that goes into solution. The universal indicator gives the entire solution a violet color, indicating a pH of about 10. (See Universal Indicator Color Chart below.) Upon adding hydrochloric acid (the simulated "stomach acid"), the mixture quickly turns red because the acid disperses throughout the beaker, first neutralizing the small amount of dissolved $Mg(OH)_2$, and then turning the solution acidic from the excess acid that is present.

Universal Indicator Color Chart

Color	Red	Orange	Yellow	Green	Green–blue	Blue	Violet
pH	4	5	6	7	8	9	10

The excess acid causes more $Mg(OH)_2$ from the suspension to gradually dissolve. As more of the $Mg(OH)_2$ goes into solution, the acid is neutralized and eventually the solution becomes basic again from the excess $Mg(OH)_2$ that is present. The addition of universal indicator allows this process to be observed. During the process, the color of the mixture goes through the entire universal indicator color range—from red to orange to yellow to green to blue and finally back to violet. By adding more "stomach acid," the process can be repeated several times before all of the $Mg(OH)_2$ is dissolved and eventually neutralized.

Disposal

Neutralize the final solution according to Flinn Suggested Disposal Method #24b. Excess milk of magnesia can be disposed of according to Flinn Suggested Disposal Method #26a. Please consult your current *Flinn Chemical & Biological Catalog/Reference Manual* for proper disposal procedures.

Acknowledgments

Special thanks to Annis Hapkiewicz, Okemos High School, Okemos, MI and to Penney Sconzo, Westminster School, Atlanta, GA for separately bringing this demonstration to our attention.

References

Summerlin, L. R.; Borgford, C. L.; Ealy, J. B. *Chemical Demonstrations: A Sourcebook for Teachers,* Vol. 2; American Chemical Society: Washington, DC. 1988; p 173.

Materials for the *Upset Tummy? MOM to the Rescue!* are available from Flinn Scientific, Inc.

Catalog No.	Description	Price/Each
H0034	Hydrochloric acid solution, 3 M, 500 mL	Consult Your Current *Flinn Catalog/Reference Manual.*
U0001	Universal indicator solution, 100 mL	
AP5934	Upset Tummy? MOM to the Rescue! Chemical Demonstration Kit	
AP1349	Magnetic Stirrer—Thermolyne Cimarec™	

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PolySnow™

Superabsorbent Polymer

Publication No. 10474

Introduction

When water is poured into a cup containing a small amount of solid, an overflowing mass of fresh powdered "snow" is produced.

Chemical Concepts

- Polymers
- Superabsorbent
- Osmosis
- Cross-linking

Materials

PolySnow™, 3.0 g
Distilled or deionized water, 150 mL
Beakers, 250-mL, 2
Sodium chloride, NaCl, 1 g

Safety Precautions

PolySnow is non-toxic. However, it is irritating to the eyes and to the nasal membranes if inhaled. Wear chemical splash goggles. Please consult the current Material Safety Data Sheet for additional information.

Preparation

Before class, add 3.0 grams of PolySnow to one 250-mL beaker.

Procedure

1. Add approximately 150 mL of distilled or deionized water to the second 250-mL beaker.
2. Slowly add the water to the beaker containing the 3.0 grams of PolySnow. The PolySnow will turn white and start to grow. Within a minute, it will overflow the beaker.
3. Add a small amount (1 gram) of sodium chloride to the beaker of PolySnow. The PolySnow will release the water and transform it to a slurry.

Additional Activities with PolySnow

- Make a batch of PolySnow and freeze it. If you live in a climate where it snows, compare the frozen PolySnow to real snow. Could PolySnow be used in place of man-made snow on ski slopes?

- Place 3 grams of PolySnow into a 1000-mL graduated cylinder. Add 150 mL of deionized water and measure the amount of swelling that occurs. Conduct experiments to determine the following:

  —How does the swelling rate change with different amounts of polymer?
  —How does the swelling rate change with different amounts of deionized water?
  —How does the rate of swelling change when PolySnow is dissolved in hot deionized water versus cold deionized water?
  —Does deionized water produce greater swelling than tap water?
  —Determine conditions to achieve the greatest amount of swelling.

- Use food coloring to color the water before adding it to the PolySnow. Fill a graduated cylinder with layers of colored "snow." Let the snow layers sit undisturbed to see if any color mixing occurs.

Discussion

PolySnow is an example of a superabsorbent polymer. Superabsorbents operate on the principle of osmosis: the passage of water through a membrane permeable only to water. In PolySnow, osmotic pressure results from a much greater concentration of sodium ion inside of the polymer lattice membrane than in the solution in which it is immersed. This osmotic pressure forces water into the solid polymer lattice in an attempt to equilibrate sodium ion concentration inside and outside the polymer membrane. The electrolyte concentration of the water will affect the osmotic pressure, subsequently affecting the amount of water absorbed by the polymer. For example, PolySnow will absorb approximately 500–800 times its own weight in distilled water, but will only absorb about 300 times its own weight in tap water, due to the high ion concentration of tap water.

PolySnow is manufactured by the free-radical polymerization of a mixture of sodium acrylate and acrylic acid, and a cross-linking molecule such as trimethylol propanetriacrylate: (Figure 1)

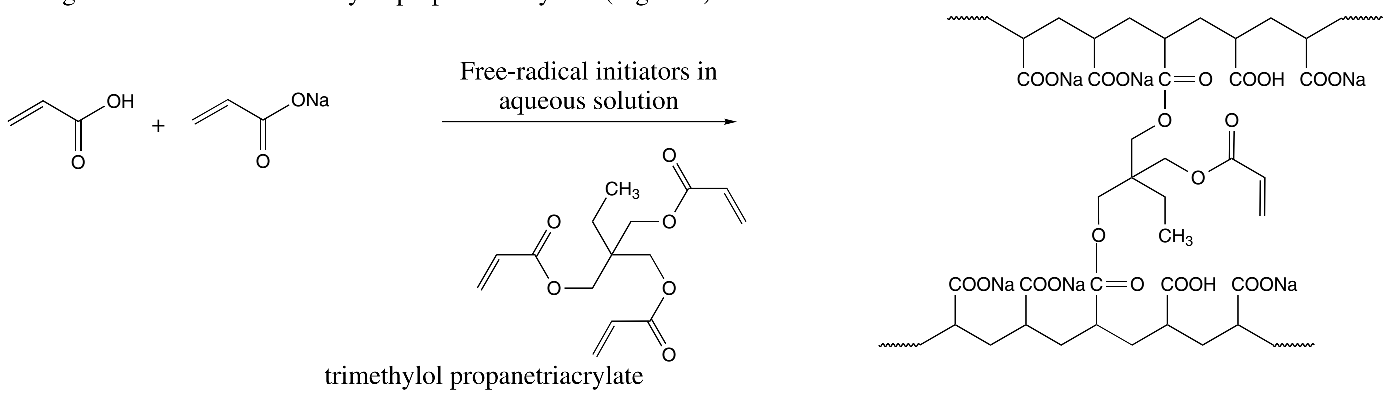

Figure 1

Disposal

PolySnow and the snow material may all be disposed of according to Flinn Suggested Disposal Method #26a. Do not put these materials down the sink! Please consult your current *Flinn Scientific Catalog/Reference Manual* for proper disposal procedures.

Acknowledgment

Special thanks to Jeff Hepburn, Dowling High School, West Des Moines, IA, for bringing this product to our attention and Steve Spangler, Cherry Creek School District, Englewood, CO, for providing us background on PolySnow.

Reference

Buchholz, F. L., *J. Chem. Ed.,* **1996,** *73* (6), 512–515.

PolySnow is available from Flinn Scientific, Inc.

Catalog No.	Description	Size	Price/Each
P0283	PolySnow™, Sodium Polyacrylate Powder	25 g	Consult Your Current *Flinn Catalog/Reference Manual.*
P0284	PolySnow™, Sodium Polyacrylate Powder	100 g	

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Sudsy Kinetics

A Foamey Demonstration

Publication No. 10216

Introduction

Teach kinetics concepts in a fun and sudsy way! This demonstration provides an interesting twist on the traditional "Old Foamey" or "Elephant Toothpaste" reaction. Not only will your students be amazed at the sudsy eruption—they will learn kinetics concepts along the way!

Chemical Concepts

- Kinetics/Catalysts
- Reaction intermediates
- Decomposition reactions
- Test for oxygen gas

Materials Needed (for each demonstration)

Alconox® detergent, 3–4 g
Hydrogen peroxide, H_2O_2, 30%, 10%, 3%, 20 mL of each
Sodium iodide solution, NaI, 2 M, 4–5 mL
Graduated cylinders, 10-mL and 100-mL, 3 of each
Graduated cylinder, 500-mL
Large, plastic demonstration tray, several inches deep
Lighter or matches and wood splint
Spoon or scoop

Safety Precautions

Hydrogen peroxide solution, 30%, is a strong oxidizing agent; it is severely corrosive to the skin, eyes, and respiratory tract; and a dangerous fire and explosion risk. Do not heat this substance. Sodium iodide solution is slightly toxic by ingestion. Although the Alconox detergent is considered non-hazardous, do not ingest the material. Do not stand over the reaction; steam and oxygen are produced quickly. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron.

This activity requires the use of hazardous components and/or has the potential for hazardous reactions. Please review relevant Material Safety Data Sheets before beginning this activity.

Procedure

Part 1 — Effect of Concentration on the Rate of the Reaction

1. Place three 100-mL graduated cylinders in a large, plastic demonstration tray. Add 20 mL of 30% hydrogen peroxide to the first cylinder, 20 mL of 10% hydrogen peroxide to the second cylinder, and 20 mL of 3% hydrogen peroxide to the third cylinder.

2. Add 1 small scoop (3–4 g) of solid Alconox® detergent to each cylinder and swirl to dissolve the detergent.
3. Measure out 5 mL of 2 M sodium iodide solution in each of three 10-mL graduated cylinders. Ask your students to predict the order at which each of the peroxide solutions will react with the iodide.
4. Ask for three student volunteers. Make sure the students are wearing chemical splash goggles; warn them to step back as soon as they pour. Have the students simultaneously pour the sodium iodide solution into the three cylinders containing the differing concentrations of hydrogen peroxide. Make observations. White foam erupts from the cylinder with the 30% peroxide the fastest, the 10% peroxide next, and only slowly rises up from the cylinder with 3% peroxide.

Part 2 — Old Foamey—Observing a Reaction Intermediate and Products

1. Place a 500-mL graduated cylinder in a large, plastic demonstration tray. Measure out 20 mL of 30% hydrogen peroxide and add it to the cylinder.
2. Add 1 small scoop (3–4 g) of solid Alconox® detergent to the cylinder and swirl the mixture to dissolve the detergent.
3. Measure out 5 mL of 2 M sodium iodide solution and, quickly but carefully, pour this into the cylinder. In a few seconds, copious amounts of white foam will be produced. Observe closely at the beginning of the reaction. A brown foam is produced at first but then turns white before it erupts out of the cylinder. This is due to the presence of the free iodine produced by the extreme oxidizing ability of the 30% hydrogen peroxide.
4. Notice the steam coming off the foam—this indicates that the decomposition reaction is quite exothermic. Light a wood splint and blow out the flame. Insert the glowing wood splint into the foam. The wood splint will re-ignite in the foam—this indicates that the gas in the foam is pure oxygen. Take the glowing splint out of the foam, re-insert it, and watch it re-ignite again. This can be repeated numerous times.

Discussion

Hydrogen peroxide decomposes to produce oxygen and water according to the decomposition reaction shown below:

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g) + \text{Energy}$$

The reaction is quite slow unless catalyzed by a substance such as iodide ions, manganese metal, manganese dioxide, ferric ions, and many other substances such as yeast or even blood. A *catalyst* is a substance that, when added to a reaction mixture, participates in the reaction and speeds it up, but is not itself consumed in the reaction. The iodide ion is used as a catalyst in this demonstration.

Disposal

The foam and any solution left in the cylinder or on the plastic tray may be rinsed down the drain with excess water according to Flinn Suggested Disposal Method #26b. Please consult your *Flinn Chemical & Biological Catalog/Reference Manual* for proper disposal procedures.

Acknowledgment

Special thanks to Walter Rohr of Eastchester High School in Eastchester, NY for bringing this demonstration to our attention.

Materials for *Sudsy Kinetics* are available from Flinn Scientific, Inc.

Catalog No.	Description	Price/Each
A0126	Alconox, 4 lb	Consult Your Current *Flinn Catalog/Reference Manual.*
H0037	Hydrogen peroxide, 30%, 100 mL	
H0028	Hydrogen peroxide, 6%, 500 mL	
H0009	Hydrogen peroxide, 3%, 500 mL	
S0084	Sodium iodide, 100 g	
AP8599	Hydrometer cylinder	
AP5429	Demonstration Tray	
AP4866	Sudsy Kinetics Chemical Demonstration Kit	